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ABSTRACT

Because of inadequate preservice and in-service mathematics training programs, a critical need existed to provide quality in-service mathematics instruction for teachers in sparsely settled areas of Appalachia. A computer assisted instruction (CAI) course was developed for use with the IBM 1500 system which utilized an integrated approach relying on tutorial activity at the computer, printed instructional materials, and manipulative devices to be used at the terminal and in the classroom. Four hundred and forty-four students registered for the course; 387 completed the course. Using data compiled from this field study the achievement and attitudes of the students were evaluated and the relationships among achievement, attitude, and time measures were analyzed. Student opinion toward CAI was surveyed. Using this data as feedback some revisions were made in the curriculum. A table of references, a course description, and a sample of the opinion questionnaire are appended. (JY)

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C·A·I

COMPUTER ASSISTED INSTRUCTION LABORATORY

COLLEGE OF EDUCATION · CHAMBERS BUILDING

THE PENNSYLVANIA STATE UNIVERSITY · UNIVERSITY PARK, PA.

INSERVICE MATHEMATICS EDUCATION VIA COMPUTER-ASSISTED INSTRUCTION FOR ELEMENTARY SCHOOL TEACHERS IN APPALACHIA

FINAL REPORT

January 1970

No. R-26

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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The Pennsylvania State University

Computer Assisted Instruction Laboratory
University Park, Pennsylvania

INSERVICE MATHEMATICS EDUCATION VIA COMPUTER-ASSISTED INSTRUCTION FOR ELEMENTARY SCHOOL TEACHERS IN APPALACHIA

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PREFACE

The conception of an idea to place a computer-instructional system in a mobile facility in order to provide inservice education for school personnel throughout Appalachia and other areas which are geographically difficult to reach can be traced to a letter written by Harold E. Mitzel, Assistant Dean for Research in the College of Education at The Pennsylvania State University, to Dr. Benjamin Carmichael, Director of the Appalachia Educational Laboratory, Inc., at Charleston, West Virginia, in May 1967. Much time and effort was devoted to nurturing this idea by the staff of the Appalachia Educational Laboratory, the Computer Assisted Instruction Laboratory at Penn State, and the International Business Machines Corporation. The Appalachia Educational Laboratory concentrated their effort on developing interest among the public school people in Appalachia and developing the financial support for such a project. The staff of the CAI Laboratory at The Pennsylvania State University concentrated much effort into revising and polishing a course in modern mathematics for elementary school teachers and the addition of components to the course to provide specific instruction in methods of teaching. Staff members from the IBM Corporation focused their attentions on the engineering and support personnel.

About March 1, 1969, an IBM 1500 instructional system was delivered to the United Data Processing facility in Dryden, Virginia, and installed ready for operation about ten days later. After serving the needs of the elementary school teachers in this community, it was then moved to the Gladeville elementary School in Gladeville, Virginia, to provide the inservice mathematics program between May 19 and July 7. It was then moved to the Philipsburg elementary School in California, Pennsylvania, where it served between July 14 and August 29. The program served a total of 387 students during the three settings of the project.

Many educators have heard that there is such a phenomenon as computer-assisted instruction, but most are unaware that the technique is beyond the developmental or laboratory stage and is ready for limited operational use in carefully selected situations. One such educational situation for which there is an urgent need is the retraining and upgrading of teachers who are currently in service. Because teachers frequently find it impossible for personal reasons to return to college campuses, the re-education they need should be taken to them. This solution to the problem of inservice education gave rise to the "extension class," which has enjoyed widespread application during the past four decades. It is, however, getting more and more difficult to staff these field courses with qualified instructors. Hence, the whole field of continuing education is ripe for a technological innovation that will bring quality instruction to practitioners in the field. This final report, based on the previous interim reports from the Dryden, Gladeville, and California experiences, shows that the computer-assisted instruction technique is successful. The students, many of whom thought that they were through with learning activities, show growth in knowledge and a high degree of enthusiasm for the individualized technique to which they were exposed.

Although a great deal remains to be done that will improve the operation of a mobile computer-based instruction unit in the field, we believe that we have demonstrated the feasibility and desirability of incorporating CAI programs into inservice teacher education.

Keith A. Hall
January 1970

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COMPUTER-ASSISTED INSTRUCTION IN APPALACHIA

Need

The importance of early mathematics education to students' intellectual growth is becoming increasingly evident. It is clear that elementary school teachers have an obligation to keep up to date and better informed in mathematics--not only about happenings which have implications for their teaching content, but also how the process of mathematics instruction might be improved.

However, an objective look reveals that the mathematics teaching skills of Appalachian elementary school teachers are, in too many instances, inadequate. There are two important reasons for this condition. The first reason is lack of effective preservice preparation. The Committee on Undergraduate Programs in Mathematics (CUPM) has recommended four mathematics courses for the preservice training of elementary school teachers. Relatively few colleges and universities have been able to make such arrangements. In fact, many new teachers entering the field have the same level of expertise in mathematics as those who presently are there.

The second reason is lack of adequate inservice education. Although many programs are offered at the state and local levels, these programs have been generally sporadic, of short duration, poorly staffed, and frequently designed solely to cope with some emergency (such as an adoption of a new textbook series).

Furthermore, attempts to improve the quality of this inservice education within the current educational framework have been frustrated by the difficulties in attracting master teachers, obtaining college credit, and arranging for release time.

Relatively few Appalachian elementary school teachers have attended a federally sponsored institute of any kind, mainly because these institutes generally require an extended stay away from home. In Pennsylvania, for example, it is estimated that there are in excess of 58,000 elementary school teachers (based on an elementary school population of 1,716,252), and only 188 of these have attended a federally sponsored institute (Bureau of Statistics, 1967, 1968).

Because of inadequate preservice and inservice mathematics training programs, there is widespread agreement that a critical need exists for new methods of providing quality inservice mathematics instruction.

In spite of the unsatisfactory conditions of current inservice programs, studies indicate that quality improvements in inservice training can and should be accomplished. Huettig and Newell (1964), for example, found that teachers with courses in modern mathematical content have a significantly better attitude toward curricular change in mathematics. Rudd (1957) found inservice courses to be of a higher caliber when individual background was taken into consideration, and the inservice course was accomplished at the local level in close proximity to the elementary classroom.

Another important finding was reported by Houston, Boyd, and DeVault (1962), who worked with 252 elementary teachers in a multi-media approach using closed circuit television, lecture, question-discussion, and written materials. They indicated that teachers preferred the written materials and the question-discussion approach of teaching. The researchers stated, "The findings of this study would [sic] indicate that administrators should consider procedures for individualizing inservice education programs for teachers." Dutton (1966) also noted that use of programed instructional materials seemed to provide numerous opportunities to diagnose students' subordinate knowledge and skills essential for sound sequential learning and expansion of mathematical concepts. In another study, Dutton and Hamlin (1966) stated that the identification of weaknesses teachers have in understanding the new mathematics and teaching to overcome those weaknesses should be an important part of an inservice program.

The research suggests that proposed teacher improvement programs should be based on the question-discussion method, individualized programs, and programed instructional materials. Computer-assisted instruction is the one technological innovation which can utilize all of these components in one comprehensive program.

Based on these studies and considerations of alternative programs, it is concluded, therefore, that a computer-based program in modern mathematics is the best choice for accelerating the accessibility of quality inservice education for mathematics teachers in Appalachia.

The primary target of the program was the teacher of elementary pupils in sparsely settled areas of Appalachia. The stereotype of this teacher is that of a woman who would have to double as a housewife and student long enough to attend college classes to upgrade her knowledge in modern mathematics. This dual responsibility often prevents the teacher from attending college; she will therefore spend another fifteen years in the classroom with no improvement in the quality of her service unless new techniques of inservice education are provided. Computer-assisted instruction offers the potential for meeting inservice training needs of the students, teachers, and the administration.

Objectives

The goal of the project was to field test a program of inservice education in modern mathematics and mathematics teaching methods for elementary teachers in the Appalachian region. An IBM 1500 instructional system was first installed in Dryden, Virginia, then in Gladeville, Virginia, and finally in California, Pennsylvania, to administer the computer-based course to the teachers. This system was used during later afternoon and evening hours to provide individualized instruction for elementary school teachers who drove in from a radius of approximately 20 miles. Records of the learning histories of the participating teachers were compiled and analyzed for evaluating the effectiveness of the course and for making course revisions.

Computer Configuration

The IBM 1500 student station consists of four optional display/response devices which may be used individually or in combination. The central instrument connected to the computer consists of a cathode-ray tube screen with sixteen horizontal rows and forty vertical columns for a total of 640 display positions. Information sufficient to fill the screen is available in micro seconds from an internal random access disk. A light-pen device enables the learner to respond to displayed letters, figures and graphics by touching the appropriate place on the screen. A part of the CRT device is a typewriter-like keyboard which makes it possible for the learner to construct responses, have them displayed at any author-desired point on the CRT screen and receive rapid feedback in the form of an evaluative message. Four dictionaries of 128 characters each of the course author's own design are capable of being used simultaneously; thus, it would be technically feasible to teach the symbols of Sanskrit, Chinese, English, and Greek simultaneously by means of CAI. An image-projector loaded with a 16mm microfilm is capable of holding 1000 images on a single roll and of accessing forty images per second under program control. An audio play/record device has recently become available but was not utilized for this project. An electric typewriter on the system is a separate device which enables the student to receive a hard copy of the interaction or dialogue between himself and the computer.

The system's central processor which can accommodate up to a total of thirty-two student stations (each complete with four devices) is an IBM 1130 computer with 32,768 words of core storage. (Sixteen stations were sufficient to allow 150 - 200 students to complete the instructional materials used for this project in about 8 weeks.) In addition to the usual peripheral equipment, the central processor depends upon five IBM 2310 disk drives (2,560,000 words) for the storage of usable course information and operative instructions. Twin magnetic tape drives record the interaction between the program and the student for later analysis and course revision. Core storage cycle time is 3.6 microseconds and read/write time for disk storage is 27.8 microseconds per word.

Instructional Program

The computer-assisted instruction course in mathematics for elementary teachers and methods of teaching mathematics for elementary teachers was developed by Professors C. Alan Riedesel, Marilyn N. Suydam, and Cecil R. Trueblood of The Pennsylvania State University. The course adheres rather closely to the CUPM Level 1 recommendation with about 80 per cent of the course devoted to mathematical content and 20 per cent devoted to the methods of teaching mathematics. The methods units were interspersed throughout the program so that each would be studied immediately following the presentation of the related content.

The course utilizes an integrated approach relying not only on tutorial activity at the computer terminal but on the integration of printed instructional materials and manipulative devices to be used at the terminal and in the teacher's classroom. Each participant in the project received a copy of Guiding Discovery in Elementary School Mathematics, by C. Alan Riedesel, and published by Appleton-Century Crofts, a handbook containing suggested lesson plans and problem assignments, and an assortment of manipulative devices, such as Cuisenaire rods and counting sticks to use in their classroom. A course description is included in Appendix A of this report. A pre- and posttest of mathematics content, and pre- and posttest of the participant's attitude toward mathematics, and a posttest of attitude toward CAI were administered to the participants in the project. The data from these inventories are documented elsewhere in this report.

Participants

Of the 444 students who registered for the course, 387 of them completed the course. Most of those who discontinued the course did so after they had attended one or two sessions and had discovered that the content of the course was not appropriate for their interests or background. Only one person was unable to complete the course because of lack of time at any setting. The enrollment by occupation and location is presented in Table 1. Of the 387 students who completed the course, 243 were enrolled for and received college credit for the course from one of the ten institutions of higher learning who agreed to offer credit for the course. The distribution of the institutions granting credit at each location is presented in Table 2.

Course Completion Time

According to the computer clock records, the average completion time was 19 hours. This average does not include pretest time, posttest time, or time used to take the "SOS" CAI opinion test at the student station. It also does not include time that students may have spent seated at a terminal but not signed on to the course itself. Minimum clock time for the fastest students (mostly high school math teachers) was 12 hours with the maximum completion time being about 56 hours.

Table 1

Enrollment of Students by Occupation and Location

Occupation	California, Pa. N	California, Pa. %	Dryden, Va. N	Dryden, Va. %	Gladeville, Va. N	Gladeville, Va. %	Univ. Park, Pa. N	Univ. Park, Pa. %	Total N	Total %
Elementary Teacher	47	45.6	90	69.7	60	43.5	17	100.0	214	55.3
Secondary Teacher	21	20.4	21	16.3	30	21.7			72	18.6
Students	11	10.7	1	.8	5	3.6			17	4.4
Administrators	6	05.8	3	2.3	16	11.6			25	6.4
Teacher Aides	4	3.9	9	7.0	7	5.1			20	5.2
Other*	14	13.6	5	3.9	20	14.5	—	—	39	10.1
	103	100.0	129	100.0	138	100.0	17	100.0	387	100.0

*Includes bus driver, carpenter, computer manager, computer operator, agriculture extension agent, guidance counselor, housewife, key punch operator, librarian, secretary, postmaster, speech clinician, and textile worker.

(elmath)

Table 2

Summary by Institute and Inservice Program Site of College Credit Received by Enrollees in Inservice Mathematics Education Program

Institution Granting Credit	Location								Total	
	California, Pa.		Dryden, Va.		Gladeville, Va.		Univ. Park, Pa.			
	N	%	N	%	N	%	N	%	N	%
Univ. of Virginia			75	58.1	64	46.4			139	35.9
Penn State Univ.	27	26.2	15	11.6	14	10.1	16	94.1	72	18.6
California State	18	17.5							18	4.6
Radford College					5	3.6			5	1.3
Univ. of Pitt.	3	2.9							3	.8
East Tenn. State			2	1.6					2	.5
Lincoln Memorial University			1	.8					1	.3
Mt. Mercy	1	1.0							1	.3
V. P. S.			1	.8					1	.3
West Virginia U.	1	1.0	—	—	—	—	—	—	1	.3
Total Enrolled for Credit	50	48.6	94	72.9	83	60.1	16	94.1	243	62.9
Not Enrolled for Credit	53	51.4	35	27.1	55	39.9	1	5.9	144	37.1
Total Enrolled	103	100.0	129	100.0	138	100.0	17	100.0	387	100.0

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EVALUATION OF ACHIEVEMENT

Harold E. Mitzel and Marilyn N. Suydam

The central question to be asked of any instructional program is, "Do the learners who are exposed to the program reach the objectives of instruction?" It is also useful to know the extent to which the instruction can be said to be causally related to the achievement of the objectives. Our goal in developing measures of achievement for the CAI modern mathematics course was to try to embrace the concepts of criterion-referenced testing as opposed to norm-referenced testing which depends upon classical psychometrics. In this connection, criterion-referenced achievement tests have to bear a much closer correspondence to the actual instructional material than is customary with the relative achievement measures used in normative evaluations. Our test-building efforts in this program of assessing the modern mathematics achievement of Appalachia inservice elementary teachers represents only an initial, imperfect attack on a new and difficult problem.

An ideal criterion-referenced test from a psychometric viewpoint would be one with items that no learner got correct prior to instruction and that every learner answered correctly at the end of instruction. (Parenthetically, it should be noted that such a test would have zero reliability.) Pragmatically, this need for a test of maximum change has to be balanced by the necessity of maintaining the motivation of learners in the pre-test situation by asking some questions which students, legitimately though uninstructed, can answer correctly. The criterion-referenced test cannot include so-called "transfer of training" questions unless those specific objectives have been included in the program of instruction. And, in order to be effective, the criterion-referenced test must measure achievement of predetermined instructional objectives rather than general intelligence. It will be clear to the reader that we did not achieve our instrumentation goals on the first attempt, but enough has been learned from this series of three presentations of the CAI modern mathematics course to make a major modification in the achievement test.

Development of the Mathematics Achievement Test

The "Test on Modern Mathematics," Forms G and H (by Marilyn N. Suydam, Cecil R. Trueblood, and C. Alan Riedesel) was developed to serve as a pre- and posttest measure of achievement for the computer-assisted mathematics course for elementary teachers (Elmath). The multiple-choice test was designed to provide a representative sampling of mathematical content from each of the twelve chapters in the course in order to measure understanding of the major concepts contained in the CAI mathematics program. Although about twenty per cent of the student's "on-line" time dealt with the material on the teaching of mathematics in the elementary school, questions from this content were not included in the achievement examination.

From a pool of approximately 300 multiple-choice questions composed of items used to test a previous version of the course (Long and Riedesel, 1967), the basic examination was constructed. The pool had been developed by writing test questions which fit the knowledge, understanding,and application objectives included in each chapter. Texts in mathematics education which were used to construct the course were consulted in the preparation of the test questions. In addition, the authors of the test were assisted by a mathematician who evaluated each item for appropriateness to the course material and for mathematical accuracy. This test in our opinion represents a first approximation to a criterion-referenced examination on which a population of elementary teachers should be expected to achieve a mastery level of about ninety per cent after instruction.

Form G of the "Test on Modern Mathematics" was used as the pretest, while Form H served as the posttest. The two forms contain the same items, except that: 1) the numerical values are changed in about one-half of the examples, and 2) the order of answer options is different on almost all items. Because there were no substantive changes in content or format, we make the assumption that Forms G and H are equivalent. Time and the appropriate number of experimental subjects from the population of elementary school teachers were not available to collect the data needed to establish psychometric equivalence.

Table 3 shows the pre- and post-treatment results of the administration of the "off-line" mathematics achievement test. A total of 342 persons from

Table 3

Descriptive Summary of 80-item Mathematics Achievement Test Scores (in per cent)
for 342 Educators Taught by CAI at Three Locations
Spring and Summer 1969

	Frequency											
Per Cent of Criterion Test Correct	Dryden, Va. (N=119)			Gladeville, Va. (N=134)			California, Pa. (N-89)			Total (N=342)		
	Pre-	Post-		Pre-	Post-		Pre-	Post-		Pre-	Post-	
95 - 99	1	10		1	8		0	4		2	22	
90 - 94	3	10		5	14		3	10		11	34	
85 - 89	6	13		7	9		5	11		18	33	
80 - 84	2	16		4	12		5	10		11	38	
75 - 79	0	16		3	16		2	14		5	46	
70 - 74	7	14		5	14		8	12		20	40	
65 - 69	3	12		8	9		10	9		21	30	
60 - 64	9	7		5	11		8	12		22	30	
55 - 59	14	5		9	9		6	1		29	15	
50 - 54	9	7		14	10		6	1		29	18	
45 - 49	9	2		14	12		17	1		40	15	
40 - 44	13	2		20	5		8	1		41	8	
35 - 39	17	3		11	2		6	2		34	7	
30 - 34	15	0		16	3		3	0		34	3	
25 - 29	7	2		8	0		1	1		16	3	
20 - 24	3	0		3	0		0	0		6	0	
15 - 19	0	0		1	0		1	0		2	0	
10 - 14	1	0		0	0		0	0		1	0	
			Change			Change			Change			Change
Mean	49.86	73.97	+24.11	51.40	69.65	+18.25	58.07	74.98	+16.91	52.60	72.54	+19.94
Median	46.44	76.22	+29.78	47.36	71.64	+24.28	56.58	76.11	+19.53	49.12	74.72	+25.60
Mode	37.00	79.50	+42.50	42.00	77.00	+35.00	47.00	77.00	+30.00	42.00	77.00	+35.00
Standard Deviation	18.37	15.99	- 2.38	19.06	17.30	- 1.76	16.90	12.92	- 3.98	18.58	16.22	- 2.36

three different locations provided usable and identifiable answer sheets for the two test administrations, which were taken approximately seven weeks apart. In the intervening period, the teachers spent an average of nineteen hours on the course material.

In studying the results of Table 3, we make the assumption that the eighty items of the test represent an absolute criterion of achievement in this course and that theoretical mastery of the course objectives is attained when a student answers all eighty items correctly. In most practical achievement testing situations, a ninety per cent criterion is ordinarily considered realistic. In the case of Forms G and H, we find considerable discrepancy from that goal, which we attribute to two causes. First, the items, being a first cut, do contain some "transfer of knowledge" objectives which were not specifically taught in the CAI program. Second, there are probably not enough direct practice materials and short quizzes within the program to enable the less able students to reach all of the desired objectives. The first difficulty can be overcome by a careful re-examination of the hierarchy of tasks involved in the solution of the problems. The second difficulty can be ameliorated by additions and deletions to the program of instruction. As shown in Table 3, approximately fifty per cent of the students had, by virtue of their performance on the pretest, already achieved fifty per cent of the content objectives of the course. For this group, there was relatively little room to grow and, in the pragmatics of an inservice teacher education offering, it was impossible to withdraw the opportunity for self-improvement from the students once the pretest results were available.

We have omitted the usually reported measures of test reliability based on the discriminating power of the accumulated test questions. These considerations are inappropriate for situations where mastery of subject matter is desired instead of each learner's relative position on an achievement scale.

In spite of the imperfections in the achievement test (and/or the instruction program), the data show that the students at the three locations were able to increase their median achievement from approximately fifty per cent to about seventy-five per cent after a seven-week period of concentrated instruction via CAI. Roughly, a twenty-five per cent increase in mathematics knowledge can be attributed to the impact of the course within the interpretative limitations of the test's characteristics. No other experiences with the content of mathematics were reported by the students during the seven-week period. Indeed, by teaching a full schedule in the Virginia or Pennsylvania public schools and commuting to the CAI installations two or three days per week, little time could have remained to the teachers for independent study of mathematics.

No attempt has been made to evaluate the small differences between means of students from the three locations because we were not concerned with the geography of mathematical achievement. Indeed, a meaningful comparison is impossible because of our inability to generate representative samples from extant populations of educators.

EVALUATION OF ATTITUDES TOWARD MATHEMATICS

Marilyn N. Suydam and Harold E. Mitzel

When a new instructional technique becomes available, educators frequently are interested in the attitudinal effects of the methodology on the subject matter being taught. Computer-assisted instruction is of particular interest in this connection because of humanistic fears that machines will somehow replace fundamental human activities. In the case of attitudes toward mathematics and things mathematical, we are, to be sure, more concerned with pupils than with teachers. However, if computer usage can awaken dormant interests of elementary teachers in mathematics, then they may be able to transmit an enthusiasm and positive attitude to their pupils. For these reasons, we were interested in studying attitude change on the part of Appalachia elementary teachers who spent a seven-week period on a computer-assisted instruction course in modern mathematics.

Development of the Mathematics Attitude Scale

The "Attitude Toward Mathematics" scale (by Marilyn N. Suydam and Cecil R. Trueblood) was developed from a pool of seventy-five items selected to express various feelings toward mathematics. The Likert format was used with each statement worded in such a way that its content is favorable or unfavorable toward the subject under study. Students then respond in terms of the extent to which they agree or disagree with the statement. Neutral items are not included. To reduce the potential effect of response set, care was taken to include an equal number of positively worded (favorable to mathematics) and negatively worded (unfavorable to mathematics) items.

The seventy-five item pool was submitted to twenty-five examinees who were asked to respond to each item with a five-point scale ranging from "strongly agree" to "strongly disagree." Scale scores were then derived for each item, and the final selection of twenty-six items was based on: 1) the level of the scale scores and 2) independence of content of the item.

The value of the variate on the attitude scale was obtained by assigning arbitrary numerical weights to the options according to the following scheme:[1]

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Positively Worded Items	1	2	3	4	5
Negatively Worded Items	5	4	3	2	1

The theoretical extremes of a distribution of scores with 26 items are 26 and 130.

On administrations of the "Attitude Toward Mathematics" scale to several hundred students, the reliability (i.e., a measure of internal consistency, Cronbach's Coefficient Alpha) has ranged from .9207 to .9793, with an average reliability of .9554.

Results

The "Attitude Toward Mathematics" scale was administered on a pretest, posttest basis to the adults enrolled in the computer-presented Elmath course at Dryden, Virginia; Gladeville, Virginia; and California, Pennsylvania. The scale was given at the time of registration or at the first instruction session. After the seven-week instruction period, the students were given the scale items and a response sheet with instructions to mail in their reactions at their earliest convenience.

Table 4 summarizes the pre-post attitudinal data for 320 students from the three combined locations. Our interest here was in ascertaining the nature of the impact of the CAI experience on attitudes toward mathematics. Fears that interaction with computer terminals might generate negative feelings

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[1] Items are scored on a one-to-five basis rather than zero-to-four in order to facilitate computer processing of the data. Specifically, when zero scores can legitimately occur, the computer cannot easily distinguish zeroes from omits unless a special character compare function is performed. This operation must be carried out for each item score which substantially increases processing time. Consequently, the computer program was written to handle positive, non-zero numbers.

Table 4

Descriptive Summary of Pre- and Posttest Attitude Scale Scores for 320 Educators Taught Mathematics by CAI at Three Appalachia Locations
Spring and Summer 1969

	Frequency											
	Dryden, Va. (N=97)			Gladeville, Va. (N=134)			California, Pa. (N=89)			Total (N=320)		
Score	Pre-	Post-		Pre-	Post-		Pre-	Post-		Pre-	Post-	
130 -	2	2		0	0		2	0		4	2	
120 - 129	4	8		5	6		4	0		13	14	
110 - 119	10	15		17	18		15	9		42	42	
100 - 109	15	22		26	25		19	16		60	63	
90 - 99	24	23		35	33		13	18		72	74	
80 - 89	22	13		20	22		16	14		58	49	
70 - 79	8	7		13	16		5	15		26	39	
60 - 69	6	5		14	11		8	8		28	24	
50 - 59	6	2		2	2		4	5		12	9	
40 - 49	0	0		1	0		1	3		2	3	
30 - 39	0	0		1	1		1	0		2	1	
- 29	0	0		0	0		1	0		1	0	
			Difference			Difference			Difference			Difference
*Mean	91.94	98.22	+6.28	91.99	92.93	+0.94	92.82	96.46	+3.64	92.21	95.51	+3.3-
Median	92.20	98.85	+6.65	94.07	94.05	-2.02	96.04	88.43	-7.61	89.97	94.23	+4.56
Mode	95.50	95.50	-	95.50	95.50	-	105.50	95.50	-10.00	95.50	95.50	-
*St. Dev.	17.87	17.05	-0.82	17.75	17.50	-0.35	21.69	18.15	-3.54	18.97	17.66	-1.31

*Descriptive statistics calculated from ungrouped data.

toward subject matter were unfounded. The average pre-post difference of +3.3 points reassured the authors that the CAI work in mathematics had not "soured" our students on the importance or their acceptance of mathematics. Hopefully, further computer use in teacher education will illuminate the subject of mathematics and the teaching of mathematics in such a way that greater enthusiasm for it will be demonstrated by elementary teachers who will, in turn, communicate that excitement to their young pupils.

ANALYSIS OF RELATIONSHIPS AMONG ACHIEVEMENT, ATTITUDE, AND TIME MEASURES

Harold E. Mitzel

In previous sections of this report we have summarized and presented the accumulated evaluative data from three locations at which the inservice CAI program was presented. In the present section our data are restricted to the last two locations, Gladeville, Virginia, and California, Pennsylvania, omitting the Dryden, Virginia, data which were not available in sufficient detail for these analyses.

Variability of Time on Terminal

It seems to be a universal phenomena that CAI as an educational medium maximizes differences between learners in the amount of time required for task completion. Our current experience is no exception to this finding as shown in Table 5. We believe that programs of instruction even richer in individualizing techniques and remedial exercises will expand the variability that we have found. Our data show that one person spent more that 39 hours at the terminal and 3 persons out of the group of 222 spent 9 hours or less at the computer terminal in the same course of instruction. This slowest-to-fastest ratio of four or five to one is characteristic of previous experiences with the course. The fact that the California, Pennsylvania, group required almost three hours less of terminal time is partially explained by three conditions: 1) California educators brought somewhat higher pre-course modern mathematics skills to the experience than Gladeville students, 2) the offering during the summer recess at California instead of during the school term enabled the Pennsylvania educators to take advantage of slightly fewer but longer sessions on the average than Virginia teachers, 3) by constantly improving the quality of the program stored in the computer, we were able to reduce slightly the average completion time required by our subjects, thus favoring those who were last on the revised material.

Table 5

Frequency Distributions of Number of Hours of Terminal Time for Educators Taught Modern Mathematics by CAI at Two Locations, Spring and Summer 1969

Number of Hours	Frequency Gladeville, Va. (N=133)	 California, Pa. (N=89)	 Total (N=222)	Cumulative Percentage
39.1 - -	1	0	1	100.0%
36.1 - 39.0	0	0	0	99.5
33.1 - 36.0	4	1	5	99.5
30.1 - 33.0	2	1	3	97.3
27.1 - 30.0	6	5	11	95.9
24.1 - 27.0	13	3	16	91.0
21.1 - 24.0	25	6	31	83.8
18.1 - 21.0	21	11	32	69.8
15.1 - 18.0	32	25	57	55.4
12.1 - 15.0	20	24	44	29.7
9.1 - 12.0	9	10	19	9.9
- - 9.0	0	3	3	1.4
*Mean	19.65	16.82	18.51	
Median	18.81	15.92	17.34	
Mode	17.05	17.05	17.05	
*Std. Dev.	5.79	5.26	5.74	

*Descriptive statistics calculated from ungrouped data.

It is noteworthy that about 70 per cent of the students were able to complete the material in 21 or fewer clock hours. Authors of the course judge that the same amount of subject matter is typically presented in lecture discussion classes in 35-40 clock hours.

Concentration of CAI Instruction

Tables 6 and 7 which follow, provide ample evidence of the degree to which adult learners will, when given the opportunity, choose to vary the concentration of their instruction. The typical adult student attended about nine separate sessions at the computer terminal and spread his instruction over a period of 30 calendar days. The "booking" arrangements for individualized instruction which we made with these students were designed to make CAI maximally flexible. It is clear from these data that our students took advantage of the opportunities afforded them. In making the course as flexible as possible we have probably ignored the wisdom generated in previous research on massed versus distributed practice (Underwood, 1961). We believe the CAI format with its control of stimulus materials offers a good opportunity to re-examine previous conclusions about learning.

Interrelationships Between Achievement, Attitude, and Time Measures

It is often useful in explorations of new techniques to examine the interrelationships between pairs of the principal variables in order to formulate hypotheses for future definitive studies. In this instance, we show in Table 8, the pair-wise relationships among seven variables for something over two hundred subjects at two Appalachia locations. There are two achievement variables, a pretest and a posttest; two attitude-toward-CAI variables, a pretest and a posttest; and three time measures, number of hours at student terminal, number of separate CAI sessions, and number of calendar days between first and last session. Table 9 which follows, is intended to provide a reference for the reader who wishes to examine the means and standard deviations for the seven variables.

Table 9 presents the product-moment correlations between the paired observations for these seven variables. It was expected that a high positive correlation would be found between achievement pre- and posttest scores. This is a generally prevalent finding since what a student achieves may be partially predicted by his entering level, or what he has achieved in the past. The correlation coefficient of .7962 is therefore an indication that high achievers

Table 6

Frequency Distributions for Number of Sessions on Terminal for Educators Taught Modern Mathematics by CAI at Two Locations, Spring and Summer 1969

Number of Sessions	Frequency Gladeville, Va. (N=120)	 California, Pa. (N=89)	 Total (N=209)	Cumulative Percentage
21 - 22	1	0	1	100.0%
19 - 20	0	1	1	99.5
17 - 18	3	1	4	99.0
15 - 16	3	2	5	97.1
13 - 14	4	5	9	94.7
11 - 12	19	14	33	90.4
9 - 10	38	22	60	74.6
7 - 8	32	22	54	45.9
5 - 6	13	18	31	20.1
3 - 4	4	4	8	5.3
0 - 2	3	0	3	1.4
*Mean	9.07	8.79	8.95	
Median	8.92	8.55	8.78	
Mode	9.50	8.50	9.50	
*Std. Dev.	3.18	3.09	3.13	

*Descriptive statistics calculated from ungrouped data.

Table 7

Frequency Distributions for Number of Days Intervening Between Initial and Final Sessions for Educators Taught Modern Mathematics by CAI

Number of Days	Frequency			Cumulative Percentage
	Gladeville, Va. (N=120)	California, Pa. (N=89)	Total (N=209)	
44 - 47	1	0	1	100.0%
40 - 43	6	0	6	99.5
36 - 39	5	3	8	96.7
32 - 35	10	6	16	92.8
28 - 31	26	10	36	85.2
24 - 27	18	3	21	67.9
20 - 23	18	11	29	57.9
16 - 19	10	13	23	44.0
12 - 15	18	12	30	33.0
8 - 11	5	17	22	18.7
4 - 7	2	14	16	8.1
0 - 3	1	0	1	0.5
*Mean	24.30	17.15	21.25	
Median	24.83	15.96	21.22	
Mode	29.50	9.50	29.50	

*Descriptive statistics calculated from ungrouped data.

Table 8

Zero-Order and Partial Correlations Between Measures on Seven Variables for Educators Taught Modern Mathematics by CAI at Two Locations, Spring and Summer 1969

Variable a	Variable b	Gladeville, Va.		California, Pa.		Total	
		r	N	r	N	r	N
Achievement pretest score	Achievement posttest score	.7858	134	.8020	89	.7962	223
	Attitude pretest score	.6026	134	.5202	89	.5555	223
	Attitude posttest score	.6038	134	.5636	89	.5919	223
	Number of hours on terminal	-.5249	133	-.4993	89	-.5366	222
	Number of Sessions	-.4473	120	-.3805	89	-.4198	209
	Number of days between first and last session	-.2918	120	-.1783[a]	89	-.3022	209
Achievement posttest score	Attitude pretest score	.4622	134	.4993	89	.4681	223
	Attitude posttest score	.5646	134	.5427	89	.5585	223
	Number of hours on terminal	-.5748	133	-.4938	89	-.5635	222
	With achievement pretest constant	-.3087	133	-.1805[a]	89	-.2670	222
	Number of sessions	-.4079	120	-.2965	89	-.3669	223
	With achievement pretest constant	-.1116[a]	120	-.0157[a]	89	-.0644[a]	209
	Number of days between first and last session	-.2181	120	-.1655[a]	89	-.2496	223
	With achievement pretest constant	.0104[a]	120	-.0385[a]	89	-.0147[a]	209
Attitude pretest score	Attitude posttest score	.8423	134	.8292	89	.8316	223
	Number of hours on terminal	-.1927	133	-.2526	89	-.2142	222
	Number of sessions	-.2261	120	-.3234	89	-.2714	223
	Number of days between first and last session	-.1730[a]	120	-.2196	89	-.1996	223
Attitude posttest score	Number of sessions	-.2580	120	-.3186	89	-.2869	223
	Number of hours	-.2846	133	-.2755	89	-.2944	222
	Number of days between first and last session	-.1966[a]	120	-.2247	89	-.2404	223
Number of Hours on terminal	Number of sessions	.7828	119	.6071	89	.7035	208
	Number of days between first and last session	.4947	119	.2283	89	.4337	208
Number of sessions	Number of days between first and last session	.5708	120	.6864	89	.5935	223

[a] Not significantly different from zero at the .05 level ($P > .05$)

Table 9

Means and Standard Deviations on Seven Variables for Educators Taught Modern Mathematics by CAI at Two Locations, Spring and Summer 1969

Variable	Gladeville, Va.			California, Pa.			Total		
	Mean	S. D.	N	Mean	S. D.	N	Mean	S. D.	N
Achievement pretest raw score	40.48	15.28	134	46.34	13.61	89	43.03	14.85	223
Achievement posttest raw score	55.33	13.95	134	59.60	11.31	89	57.03	13.10	223
Attitude pretest raw score	91.99	17.82	134	92.82	21.81	89	92.32	19.47	223
Attitude posttest raw score	92.93	17.46	134	96.46	18.26	89	94.34	17.83	223
Number of hours "on-line" at terminal	19.65	5.79	133	16.82	5.26	89	18.51	5.74	222
Number of separate sessions	9.07	3.18	120	8.79	3.09	89	8.95	3.13	209
Number of days between first and last session	24.30	9.05	120	17.15	9.37	89	21.25	9.83	209

on the pretest tended to be high achievers on the posttest, and low achievers tended to achieve at the lower levels on both tests. If, however, the achievement test were a completely satisfactory mastery or criterion-referenced test, this correlation should be decidedly lower. The goal in aiding the student to achieve mastery of a body of material is precisely to eliminate a strong pre-post achievement test relationship. All students, whether they scored high or low on the pretest, should reach approximately the same high level on the posttest if the individualized course of instruction is optimized. The present achievement test for the course as well as the course itself is undergoing revision in order to more closely approximate the goal.

That the attitude pre- and posttest scores were highly correlated was also predictable. Measurable changes in attitude generally demand a longer time span than the seven weeks of this project. The correlation coefficient of .8316 is indicative that some relative changes in attitude did occur among the participants; as previously noted, the mean attitude score became slightly more positive during the instruction period, though the difference did not exceed chance variation.

The correlation coefficients between measures of achievement and attitude toward CAI on the one hand, and time assessments on the other, are all low negative. This observation is merely indicative of the fact that longer periods of time spent by students on the course tended to be associated with lower achievement, both pre and post. It is, of course, difficult to say that one set of variables is causally related to the other.

The negative coefficients between achievement and attitude on the one hand and time-on-course measures on the other, however, are generally not extreme. One exception is the relationship between pre- and posttest achievement and amount of time on the terminal (-.5366 and -.5635, respectively). High achievers typically spent less time at the student station than low achievers. Again we see some weakness in the combination of instructional programs/examinations, since theoretically learners with lower ability or lower previous knowledge should be able to use "time on the program" to compensate for their poor starting position.

Amount of time on terminal was found to be positively related to the number of sessions (.7035) and the number of lapsed days between first and last session (.4337). That these coefficients were no higher is related to the flexibility of scheduling possible with a CAI system. The coefficient of .5935 between numbers of sessions and lapsed days is similarly related to scheduling constraints.

The data relating to time "on-line" and achievement were also analyzed in another way to study the relationships existing between them. Correlations between posttest achievement and each measure of time were determined when achievement pretest scores were used as a co-variate, or held constant. Thus it was possible to look at the relationship which would have existed had all pretest achievement scores been equal. The correlation coefficients between posttest achievement score and number of lapsed days (with pretest achievement constant) was -.0147, while the posttest achievement coefficient with number of sessions was -.0644 under the same conditions. Both of these coefficients are statistically nonsignificant. However, the coefficient between posttest achievement and number of hours on terminal (with pretest achievement constant) was -.2670. When pretest achievement was uncontrolled, the corresponding coefficient was -.5635, indicating that a portion, but not all, of the relationship between achievement and time on the terminal is explained by what the learner brings with him in the way of subject matter knowledge.

Summary

The adaptions spontaneously made by the students in terms of length of CAI sessions, number of different sessions, and spread of instruction over number of days tend to emphasize one of the potentially important advantages of computer-based instruction. A maximum amount of flexibility seems to be of particular significance for inservice or job concurrent training. We believe that the educational demand for inservice education is going to increase markedly in the years immediately ahead, and that CAI, based on our field experiences in Appalachia can help to satisfy that burgeoning need.

EXPRESSED STUDENT OPINION TOWARD COMPUTER-ASSISTED INSTRUCTION

Karl G. Borman

The evaluation of an educational innovation such as computer-assisted instruction is a multi-dimensional problem. One aspect of this evaluation is the student's opinion of the innovation.

It is generally acknowledged that the personality of the teacher is of major importance to what is learned in the classroom (Bugelski, 1964). If the teacher is flat or dull, the words that he uses will become conditioned stimuli for boredom and apathy. If he is mean, sarcastic, or irritable, his words will come to create emotional reactions of resentment. Similar reactions should result when a computer is substituted for a teacher. However, research evidence (Eigen and Feldhusen, 1964; Wodtke, Mitzel, and Brown, 1965) has indicated that student opinion toward computer-assisted instruction may not be of much consequence relative to the amount learned. Brown (1966) has suggested that the previous studies were conducted over too short a period of time to allow the effects of opinion toward computer-assisted instruction to affect learning.

The student opinion survey described in this section of the report is an instrument designed to measure a student's opinion toward computer-assisted instruction (CAI) as an educational technique.

The Student Opinion Survey (SOS)

The instrument is composed of 42 items related to the student's experiences while taking a course via CAI. The items were adapted from a paper and pencil test previously developed at Penn State (Brown, 1966) and later revised on the basis of the data collected at Dryden, Virginia, (Hall, 1969).

The student taking the opinion survey uses the light pen attached to the cathode ray tube (CRT) to indicate the degree to which he agrees with a statement (strongly agree, agree, uncertain, disagree, strongly disagree) for 26 of the questions. Sixteen questions require the student to rate the degree of applicability of the statement by using the light pen to point to one of the following responses: all of the time, most of the time, some of the time, very seldom, or never. Twenty six of the 42 questions are negatively worded (see Appendix B). A weight between 1 and 5 is assigned to each response to indicate the degree to which the response describes a favorable opinion toward CAI. This method of weighting provides for a spread of scores between 42, indicating the least favorable opinion toward CAI, and 210, indicating the most favorable opinion toward CAI. A theoretical neutral score would be 126.

Based on the data collected at Dryden, Virginia, (Hall, 1969) provisions were made in the opinion survey to give the student the opportunity to type any comment (up to 200 characters) he wished to make related to a particular item in order to clarify or explain the reasons for his answer.

Provision was also made to allow a student to type a response of not more than 200 characters explaining why he did or did not like CAI. This section of the opinion survey followed the 42 structured items. The typed comments were not scored and were not included as part of the student's score.

Administration

The administration procedures varied from site to site. Each site utilized an improved administration procedure made possible by technological improvements.

While the students at Dryden, Virginia, were taking the modern mathematics course, a sign was posted instructing the students to sign on to SOS between chapters 8 and 10. Of the 129 students who completed Elmat, 116 followed the instructions. Twenty-seven students' data were discarded because of a machine malfunction which was later corrected. Eighty-nine students at Dryden, Virginia, provided the data for that report.

At Gladeville, Virginia, the students were instructed to sign-on to SOS upon completion of the modern mathematics course. Ninety-one of the 138 students followed these instructions. However, 28 of the students completed SOS before the course was revised and these students were excluded from the analyses. Sixty-three students provided the data for that report.

The California, Pennsylvania, site provided the highest degree of control for the administration of the Student Opinion Survey. Upon the completion of the modern mathematics course, the students were automatically administered the opinion survey. Eighty-nine students provided the data for that report.

At all sites, the students were told to be frank, that there was no one right answer to a question, that their opinions would be kept confidential, and that they were required to answer each question.

Results

Because the students at Dryden, Virginia, were administered a different version of the opinion survey midway through the course on modern mathematics than the students at Gladeville and California, separate analyses were performed on the data from Dryden. The results of two analyses, Dryden separately, and Gladeville and California combined, will be presented here.

The coefficient alpha reliability (Cronbach, 1951) of the Student Opinion Survey administered at Dryden, Virginia, was .84 while the coefficient alpha reliability of the survey administered at the two other combined locations was .85.

The mean student opinion score obtained at Dryden was 154.4 and the mean average student opinion score at the remaining two locations was 155.6. The entire distribution of scores for both analyses is shown in Table 10.

It was hypothesized that a student's opinion toward CAI may be related to his performance in mathematics and the time required to complete the course. Correlations between student opinion scores and mathematics achievement posttest scores, and between student opinion scores and total time to complete the CAI course, were obtained and are reported in Table 11. Any discrepancies between the number of subjects used in these analyses and the number of subjects used in previous analyses are the result of not having opinion survey data, completion time, and posttest performance data available.

Only the correlation between student opinion survey scores and the mathematics achievement posttest scores obtained at Dryden, Virginia, was significantly different from zero. Individual analyses performed at the Gladeville and California sites did not produce correlations significantly different from zero between these same variables. The same finding is also shown in the single analysis using the combined Gladeville and California data. All of the other correlations were not significantly different from zero.

Discussion

Accepting the statement that a score of 126 indicates a neutral opinion toward CAI, then the conclusion follows that the students on the whole expressed a favorable opinion toward computer-assisted instruction because a mean score of 155.2 was obtained for all 243 of the students. Only 8 out of 243 students

Table 10

Distribution of Student Opinion Survey Scores

	Frequency	
Score	Dryden Data	Gladeville and California Data Combined
180 - 189	3	6
170 - 179	6	19
160 - 169	24	36
150 - 159	26	45
140 - 149	18	29
130 - 139	8	12
120 - 129	3	5
110 - 119	1	2
N	89	154
*Mean	154.29	155.40
Median	155.08	155.94
Mode	154.5	154.5
*St. Dev.	13.00	14.23
Reliability	.84	.85

*Descriptive statistics were calculated from ungrouped data.

Table 11

Means, Standard Deviations, and Correlation Coefficients of Two Variables Hypothesized to Affect Student Opinion Survey Scores

Variable	Mean	S. D.	Correlation with SOS	P
Dryden, Virginia (N = 86)				
Mathematics Achievement Posttest	59.95	11.97	.27	< .01
Time Required to Complete the CAI Course on Modern Mathematics	21.45	6.14	.06	N. S.
Gladeville, Virginia, and California, Pennsylvania (N = 147)				
Mathematics Achievement Posttest	57.63	12.85	.08	N. S.
Time Required to Complete the CAI Course on Modern Mathematics	17.69	5.96	-.02	N. S.

obtained student opinion survey scores of 126 or less. The low correlation between student opinion survey scores and mathematics achievement posttest scores or time required to complete the CAI course also indicates that both high and low achievers expressed favorable opinions toward computer-assisted instruction; and those students who rapidly completed the CAI course on modern mathematics, as well as those who required longer periods of time, also expressed favorable opinions toward CAI.

The one exception to these general findings is the .27 correlation between student opinion scores and mathematics achievement posttest scores obtained at Dryden, Virginia. At the present time, the most feasible explanation is that this correlation is significant by chance alone, since this result was not duplicated at subsequent locations. However, the possibility does remain that this result is due to the fact that the opinion survey was administered approximately two-thirds of the way through the course. This hypothesis must be retained until more data are obtained.

Student Comments

The favorable attitudes of students toward CAI methodology are also verified by the unstructured comments typed upon conclusion of the 42 inventory items of the student opinion survey by the students at Gladeville and California. Some typical comments follow:

> I liked this course because it's the first time I've even remotely enjoyed any type of math (except geometry). I think I've learned something at last.
>
> It was a lot of fun--stimulating.
>
> Mathematics is not one of my favorite subjects. The computer made it seem a bit different.
>
> Have always actively disliked math; thoroughly enjoyed this course.
>
> I liked the CAI course very much. In high school I hated math.
>
> A fine course.
>
> Thank you for your ideas.
>
> CAI made learning fun and enjoyable.
>
> I was pleasantly surprised at the lack of tension I felt in taking a course that was always difficult for me to master. There was a high degree of motivation. Congratulations and thanks.

> . . .You look forward to attending classes.
>
> The course was fun.
>
> I appreciated flexibility in scheduling.
>
> It gave some insight into the method of presentation of materials.
>
> I liked CAI because I could take the courses at my convenience.
>
> I felt the course was tremendous in every way. The experience was great. Thank you for making it possible, and your interest in me as a student and teacher.
>
> I liked CAI because you received immediate feedback for your responses. I am normally very poor in mathematics and I feel that it [CAI] has helped me gain a better understanding of some concepts.

There were also some negative comments, the most common was that the students could not get the computer to accept alternative correct answers. For example:

> I felt, at times, that I needed someone to explain things more, and to discuss things with me.
>
> I became a little upset when the computer refused correct answers because of different terms. Otherwise, I've enjoyed the class.
>
> I did enjoy this course. I realize that you are only a machine and that there is much improvement to be made, example, your acceptance of responses. On the whole I found it quite interesting.

Conclusion

An overwhelming majority of all the students completing the computer-assisted instruction course of inservice mathematics education for elementary school teachers at Dryden, Virginia, Gladeville, Virginia, and California, Pennsylvania, obtained scores on the Student Opinion Survey which indicated that the students had a favorable opinion toward computer-assisted instruction. This opinion was not related to a person's mathematical achievement or to the time required to complete the CAI program. The comments typed by the students upon the completion of the survey also verify these conclusions. From these findings,we inferred that the students were highly motivated to learn and would be willing to take further instruction via CAI.

CURRICULUM REVISIONS

Cecil R. Trueblood

Since the computer can automatically record and store all or selected student responses and response times, the instructors or course authors can later obtain a print-out of this student record data by means of special instructions. The purpose of this report segment is to indicate the type and number of curriculum revisions which were made based on the analyses of student records and on-site observations.

The following procedures were used to determine what curriculum revisions might be made. A request was made for a one-line summary of student performance for each question in the course. See Table 12 for an example of the types of data contained in the one-line summary.

Table 12

Example of Data in a One-line Summary

Ep Identifier[a]	Students[b]	Attempts[c]	% Attempts > 2[d]	Mean Latency[e]
D62x1	2	10	50	5.00
D62x2	2	3	0	1.50
D62x3	2	4	50	2.00
D65	10	14	9	1.40

[a] Identifies each question in the course.

[b] Number of students who have been presented with this question.

[c] Total number of attempts to respond correctly by all students who received the question.

[d] Per cent of attempts greater than two.

[e] Mean response latency in seconds.

The data in the one-line summary were analyzed to determine which question might be causing students difficulty. For any question where the mean number of attempts was greater than two, another request was made to obtain detailed student records. See Table 13 for an example of the types of data contained in the detailed student records.

Table 13

Sample of Student Records for One Student (YAMG)
on Elmat-4, Question D65

Course[a]	Seg.[b]	S[c]	Ep Ident.[d]	Match[e]	Attempt[f]
Elmat	4	YAMG	D65	UU	1
	Responses - 1111010[g]				
Elmat	4	YAMG	D65	UU	2
	Responses - 1111010[h]				
Elmat	4	YAMG	D65	CC	3
	Responses - 1011010 (two)[i]				

[a] Name of course - elmat.

[b] Segment no. 4.

[c] Student: YAMG - Y denotes Dryden setting, AMG are the student's initials.

[d] Identifies the question in the course.

[e] Identifies the type of response in the course which the student matched: UU - unanticipated response, CC - correct response.

[f] Indicates which attempt the data refers to for a given student - 1st attempt, 2nd attempt, etc.

[g], [h], and [i] Actual response made by the student.

Using the data in the detailed student records and the original program, the authors determined whether a revision of course content or Coursewriter II instructions might improve student performance. The number and types of revisions made are shown in Table 14 and discussed on the following page.

Table 14

Number of Curriculum Revisions by Type and Location Where Data Were Collected

Operation Codes Requiring Revisions	California Pa.	Dryden Va.	Gladeville Va.	Total
	Number of Revisions			
pr			5	5
ep	5		6	11
lp responses	4	7	3	14
ca	5			5
ca feedback	3	7		10
cb			9	
wa				9
wa feedback	4	38	3	45
un feedback	13	16	9	38
fn	11	125	3	139
dt	7		3	10
Branch		9		9
Image Reel		19		19
Op code		11	4	15
Typographical			3	3
Context		26		26
Student Handbook	—	12	—	12
Total	52	270	48	370

In addition to the revisions based upon student records, the recommendations of the proctors and the systems manager were used to generate new frames for several chapters. Since the need for these changes was not reflected by student records, this source of information proved to be very useful in improving the program. Two types of revisions were made based upon these on-site observations. New frames were added after which the old and new frames were resequenced to improve the course flow.

Unanticipated Answers (WA, CA, and UN Feedback)

This type revision was made when students gave correct or incorrect answers (which had not been anticipated by the authors) and received inappropriate feedback. A comparison of lines 11 and 16 on the following print-outs (Fig. 1 and Fig. 2) illustrate how these frames were revised to provide appropriate feedback. Line 11 (Fig. 2) shows that students will now receive appropriate feedback for the WA's "count" and "number." Line 16 shows that the answers "one-to-one" and "1-to-1" will not be given correct answer feedback.

```
1  pr
2  de 0/32
3  dt  0,0/6,0/40,0/Readiness for studying cardinal number
       of sets can begin with each child using
       a small flannel board and the
4  dt  ,0/2,/40,0/materials shown on the image projector.
5  fpl  27
6  dt  ,0/4,/40,0/What should the teacher ask pupils to do
       if they can't find any likenesses?
7  ep  16,0/2,16/40,0//99/1x17
8  fn  ed//b0,d//^
9  de  24/8
10 aa  */aa
11 ld  .match.pair.corres.compar/b2
12 fn  mk///.
13 fn  es/nw/l/.///c
14 dt  24,0/4,24/40,0/Good.  After pairing they recognize that
       for each boy there's a ball.
```

Fig. 1. Frame print-out before revision.

```
 1  pr
 2  de  0/32
 3  dt  0,0/6,0/40,0/Readiness for studying cardinal number
        of sets can begin with each child using
        a small flannel board and the
 4  dt  ,0/2,0/40,0/materials shown on the image projector.
 5  fpl  27
 6  dt  ,0/4,/40,0/What should the teacher ask pupils to do
        if they can't find any likenesses?
 7  ep  16,0/2,16/40,0////1x17
 8  fn  ed//b0,d//^
 9  de  24/8
10  aa  */aa
11  ld  count number/b2
12  fn  mk///^
13  fn  ex/nw/1/^///w
14  dt  24,0/4,24/40,0/What type of correspondence would help?
15  aa  */aa
16  ld  .match.pair.corres.compar.1to1.onetoone.b2
17  fn  mk///.
18  fn  es/nw/1/.///c
19  dt  24,0/4,24/40,0/Good.  After pairing they recognize that
        for each boy there's a ball.
```

Fig. 2. Frame print-out after revision--unanticipated answers.

Context Revisions

This type revision was necessary when the wording in either initial questions or possible answers delayed student progress. In the following example, student record analysis indicated that the initial question was too general to elicit the specific terms desired. An examination of lines 3 and 4 in the following frame print-outs (Fig. 3 and Fig. 4) indicates what text was added to cause students to consider two specific types of sets.

```
1  prr
2  de  0/32
3  dt  2,0/6,2/40,0/After numerous matching exercises the
   teacher should be able to introduce the
   children to what type of sets?
```

Fig. 3. Frame print-out before revision.

```
1  prr
2  de  0/32
3  dt  2,0/6,2/40,0/After numerous matching exercises the
   teacher should be able to introduce the
   children to what type of sets?  Type
4  dt  ,0/2,/40,0/either equal or equivalent.
```

Fig. 4. Frame print-out after revision--context revisions.

Branch Revisions

These revisions were made when student records indicated that some students could advance more rapidly or that some students needed additional instruction. In the following case, student records indicated that if a student correctly answered question c06, he did not need the additional examples in the branch c06x1 and c06x2. The program was revised as indicated in the following flowcharts (Fig. 5) so that students who correctly answer c06 go directly to c07.

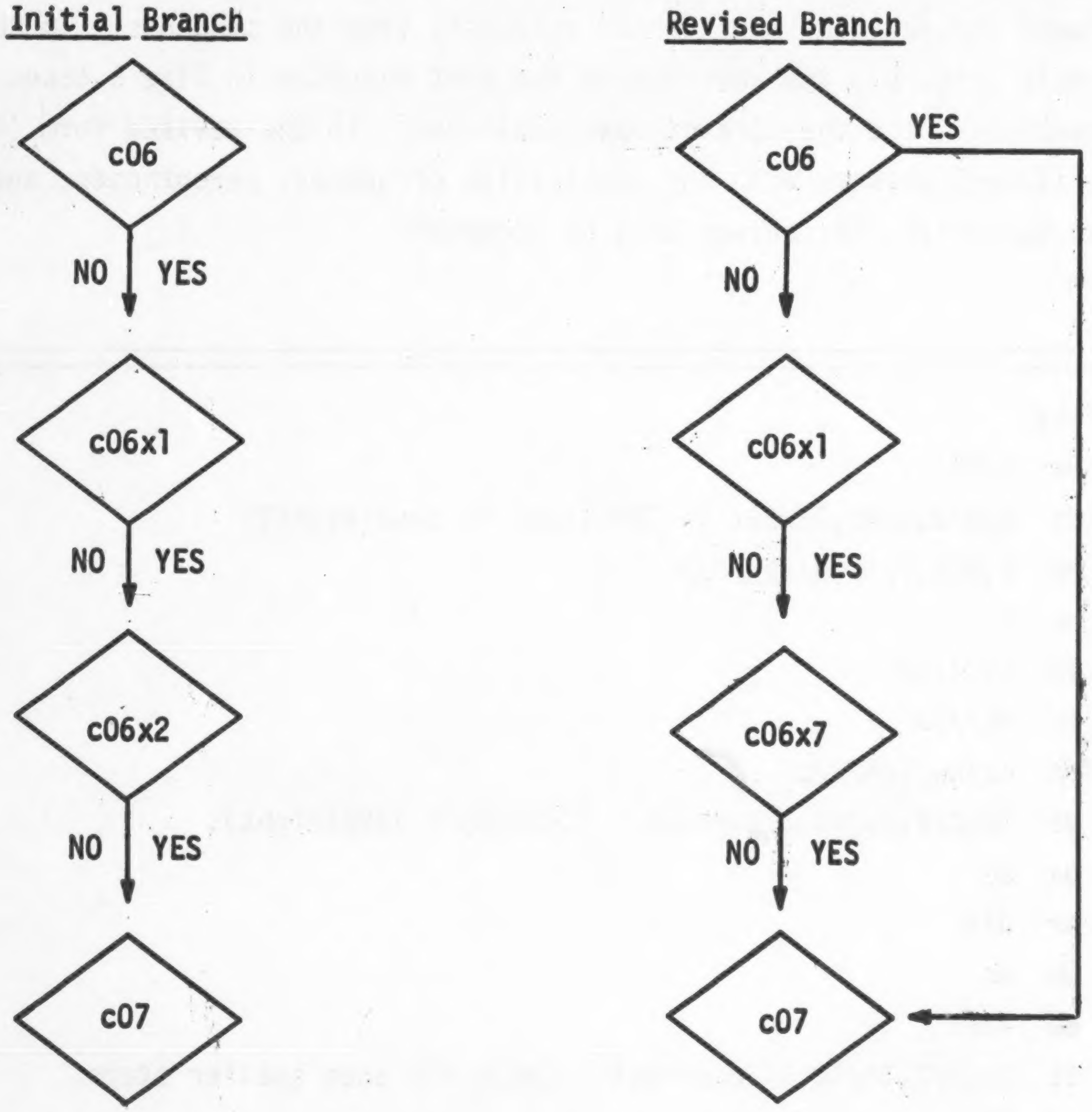
Initial Branch
Revised Branch
c06
NO
YES
c06x1
c06x2
c06x7
c07

Fig. 5. Flowcharts of program frame showing initial branch and revised branch.

Image Reel Revisions

For several questions student records and on-site observations indicated that the content of the accompanying image reel frames was impeding student progress. In these cases, students had difficulty identifying the correct answers to questions because the accompanying image reel frames were not labeled. The revision was simply to label the objects on those images. After all revisions for a reel were made, the complete image reel was rephotographed.

FN Revisions

These function revisions made the program more sophisticated in that it allowed and accepted more varied responses from the students. In the following example (Fig. 6), the addition of the edit function in line 5 takes out spaces, parentheses, and the correct base subscript. In the revised form (Fig. 7) if the student answers with any combination of spaces, parentheses, and the correct base subscript, his answer will be accepted.

```
 1  prr
 2  de  0/32
 3  dt  0,0/2,0/40,0/What is 724 (ten) in base eight?
 4  ep  2,0/2,2/40,0//99/d18
 5  aa  *
 6  ld  1324/b2
 7  fn  mk///^
 8  fn  es/nw/1/^///c
 9  dt  16,0/2,16/40,0/Correct.  724(ten) = 1324(eight).
10  pa  20
11  br  d19
12  un  un
13  de  16/2
14  dt  16,0/2,16/40,0/Incorrect.  Let's try some smaller steps.
15  pa  20
16  br  d18x1
```

Fig. 6. Frame print-out before revision.

```
 1  prr
 2  de  0/32
 3  dt  0,0/2,0/40,0/What is 724(ten) in base eight?
 4  ep  2,0/2,2/40,0//99/d18
 5  fn  ed////^/(/)/eight
 6  ca  1324/cc
 7  de  16/2
 8  dt  16,0/2,16/40,0/Correct.  724(ten) = 1324(eight).
 9  pa  20
10  br  d19
11  un  un
12  de  16/2
13  dr  16,0/2,16/40,0/Incorrect.  Let's try some smaller steps.
14  pa  20
15  br  d18x1
```

Fig. 7. Frame print-out after revision--FN revisions.

In some cases the student's typing caused him to receive the feedback for an unidentified answer. For example, before an appropriate edit function was added, the response "FOUR" was not accepted as a correct answer, only "four" was accepted; therefore, the edit function in line 5 (Fig. 8 and Fig. 9) was used to downshift all capital letters and to take out all spaces.

OP Code Revisions

The need for OP code revisions to gain the desired course affect was determined from on-site observations.

One PA (pause) revision altered the length of pause between multiple lightpen responses. This revision was necessary to keep students from becoming confused about whether or not the computer had accepted their first choice and was prepared to accept their second choice. Also, if the student responds with

```
 1  prr
 2  de  0/32
 3  dt  0,0/6,0/40,0/Consider the letters in the word "card."
    How many members or elements are in
    this set of letters?
 4  ep  8,0/2,8/40,0//99/a3
 5  de  16/16
 6  ca  4/cc
 7  cb  four/cc
 8  dt  16,0/2,16/40,0/4 is correct.
 9  pa  20
10  un  un
11  dt  16,0/6,16/40,0/The word "card" has four letters.  How
    many elements would this be?  Now answer
    again.
12  un  un
13  dt  16,0/6,16/40,0/"Card" contains 4 letters.  Therefore,
    there are four elements in this set
    of letters.  Type 4.
```

Fig. 8 Frame print-out before revision

a wrong answer, the computer now, 1) erases any previous feedback, 2) pauses, 3) gives the new feedback, 4) pauses, and allows the student to begin his next attempt.

The OP code revisions also permit: 1) changing an EP (enter and process) to give students more space in which to construct his response, 2) inserting an EP when there wasn't one so that students can answer, 3) inserting a UN (unrecognized answer) to correct the flow of the program, and 4) inserting a PR (problem start) at the beginning of a frame.

```
1  prr
2  de  0/32
3  dt  0,0/6,0/40,0/Consider the letters in the word "card."
   How many members or elements are in
   this set of letters?
4  ep  8,0/2,0/40,0//99/a3
5  fn  ed//b0,d//^
6  de  16/16
7  ca  4/cc
8  cb  four/cc
9  dt  16,0/2,16/40,0/4 is correct.
10 pa  20
11 un  un
12 dt  16,0/6,16/40,0/The word "card" has four letters.  How
   many elements would this be?  Now answer
   again.
13 un  un
14 dt  16,0/6,16/40,0/"Card" contains 4 letters.  Therefore,
   there are four elements in this set
   of letters.  Type 4.
```

Fig. 9. Frame print-out after revision--FN revisions.

The omission of the PR in the example frame (Fig. 10) affected the course flow in that students received the frame labeled c21 before they had correctly answered c20. The addition of the PR in line 1 of the revised frame (Fig. 11) corrected this problem.

Student Handbook Revisions

Revisions in the Handbook included correction of a few typographical and content errors and inclusion of omitted pages. Student reaction and on-site observation were also used to make improvements in the second printing of the Handbook.

```
c20
   1  de  0/32
   2  dt  0,0/6,0/40,0/Instead of writing out, for example,
          "3 hundreds + 4 tens + 7 ones," we might
          use a chart like this:
   3  pa  60
   4  dti 7,0/2,7/40,0/Hun-
   5  dti 9,0/4,9/15,0/dreds  Tens Ones
   6  dti 8,17/2,8/23,17/Numerals  Word name
   7  dti 13,3/2,13/20,3/3    4    7   347
   8  dti 12,27/2,12/13,27/three hundred
   9  dti 14,27/2,14/13,27/forty-seven
  10  pa  60
  11  dti 18,3/2,18/12,3/3    6    7
  12  dti 17,27/2,17/13,27/three hundred
  13  dti 19,27/2,19/13,27/sixty-seven
  14  epi 18,20,2,18/3,20//3/c21
  15  ca  367/cc
  16  dt  24,0/2,24/40,0/Yes.  367 = 3 hundreds + 6 tens + 7 ones.
  17  pa  50
  18  de  24/2
  19  br  prl
  20  un  un
  21  24,0/2,24/40,0/No, try again.
  22  pa  30
  23  un  un
  24  dt  24,0/2,24/40,0/The numeral is 367.  Type 367.
  25  pa  30
c21 1  pr
```

Fig. 10. Frame print-out before revision

```
c20
  1  pr
  2  dt  0/32
  3  dt  0,0/6,0/40,0/Instead of writing out, for example,
         "3 hundreds + 4 tens + 7 ones," we might
         use a chart like this:
  4  pa  60
  5  dti 7,0/2,7/40,0/Hun-
  6  dti 9,0/4,9/15,0/dreds  Tens  Ones
  7  dti 8,17/2,8/23,17/Numerals  Word name
  8  dti 13,3/2,13/20,3/3    4    7   347
  9  dti 12,27/2,12/13,27/three hundred
 10  dti 14,27/2,14/13,27/forty-seven
 11  pa  60
 12  dti 18,3/2,18/12,3/3    6    7
 13  dti 17,27/2,17/13,27/three hundred
 14  dti 19,27/2,19/13,27/sixty-seven
 15  epi 18,20/2,18/3,20//3/c21
 16  ca  367/cc
 17  24,0/2,24/40,0/Yes.  367 = 3 hundreds + 6 tens + 7 ones.
 18  pa  50
 19  de  24/2
 20  br  prl
 21  un  un
 22  dt  24,0/2,24/40,0/No, try again.
 23  pa  30
 24  un  un
 25  dt  24,0/2,24/40,0/The numeral is 367.  Type 267.
 26  pa  30
crl 1  pr
```

Fig. 11. Frame print-out after revision--OP code revisions.

On-line Course Evaluation

Two forms of a general achievement test have been put on-line--the pretest (Form I), and the posttest (Form J). The 80 items on the pre- and posttests are all multiple-choice questions, and they can be answered by using the keyboard. All the students will receive the same six questions in the beginning and the same six questions at the end. The other 68 questions are randomly generated and therefore vary in the order in which each student receives them.

The second test placed "on-line" is a 26-item mathematics attitude scale. It will be given to determine the student's attitude toward mathematics before and after completing the course. Since the choices on this test vary on a continuum from agree to strongly disagree, students will respond by using the light pen. They will also be encouraged to make any comments they wish following their response to each item.

The use of on-line course evaluation was initiated for several reasons: 1) to standardize and at the same time individualize the administration of the pre- and posttests, 2) to take advantage of student record feedback for future course revision, and 3) to gain the possibility of being able to investigate some of the problems related to testing students via CAI.

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2

APPENDIX A

Course Description: elmath

COURSE DESCRIPTION: elmath

The CAI course elmath is designed to present mathematical content and methods of teaching that content in the elementary school. The content component was developed at The Pennsylvania State University by Dr. C. Alan Riedesel and Dr. Marilyn N. Suydam. The methods component was developed by Dr. Cecil R. Trublood with Dr. Riedesel and Dr. Suydam.

The primary purpose of the content materials is to present the mathematics which a teacher should know in order to develop a successful program in the elementary school. It is based on CUPM recommendations for Level 1 courses, modified to meet the actual requirements of the schools in which it is visualized for use. The methods materials place stress on various strategies and techniques, including the use of manipulative materials.

As over-all learning outcomes, the teacher should be able to understand and apply:

(1) the mathematical content
(2) generalizations about teaching procedures, including:
    (a) Physical world situations should be used to facilitate concept development.
    (b) Many varying materials should be used to facilitate concept development.
    (c) Experiences should range from the concrete to the abstract.
    (d) Individual differences must be considered in planning and in teaching.
    (e) Pupils should be asked to discover and use many varying ways of finding solutions to problems.
    (f) Pupils should be asked to explain, deduce, generalize, and apply.
    (g) Questions of many types should be asked to provoke discussion, develop concepts, and refocus on problems.

In addition to the CAI program, a textbook on teaching elementary school mathematics is required: Riedesel, C. Alan, Guiding Discovery in Elementary School Mathematics (New York: Appleton-Century-Crofts, 1967). A handbook with a summary of mathematical content and a section on activities and materials to use in the classroom is also provided: Part I, Help to You in

Learning Mathematics, by Roy F. Shortt (Keuka College, Keuka Park, New York), and Part II, Help to You in Teaching Mathematics, by Cecil R. Trueblood (The Pennsylvania State University).

For use in evaluation of learning, there are an eighty-item test ("A Test on Modern Mathematics," Forms G and H, by Marilyn N. Suydam, Cecil R. Trueblood, and C. Alan Riedesel) and an attitude scale ("Attitude Toward Mathematics," by Marilyn N. Suydam and Cecil R. Trueblood). A scale to measure changes in attitude toward CAI is also available.

An outline of the course follows.

Chapter 1: Sets and Early Number Experiences

Content

1. Sets
    a. Elements of sets
    b. Finite and infinite sets
    c. Defined sets
    d. Set notation
    e. Empty set
    f. Universal set
    g. Subsets

2. Set relationships
    a. Equality
    b. Equivalence

3. Set operations
    a. Union
    b. Intersection

4. Complement of a set

Methods

This section focuses attention on why and how sets are presented in early number work. Attention is also directed toward the materials and techniques the teacher should use and the questions she should ask. Levels of pupil performance are considered in terms of types of pupil response.

Chapter 2: Exponents

Content

1. Interpreting exponential notation
    a. Repeated factors
    b. Powers: base and exponent

2. Expressing in exponential form

3. Expanding from exponential form

4. Computation with exponents
    a. Multiplication
    b. Division
    c. Addition and subtraction

5. Zero as an exponent

6. Using expanded notation

Methods

How to teach exponential notation so that pupils see its usefulness is featured. Various pupil-teacher exchanges are presented. Use is made of graph paper and blocks to illustrate exponential forms.

Chapter 3: The Hindu-Arabic System

Content

1. Numerals and word names for numbers

2. Place value
    - a. Numerals and names through thousands place
    - b. Patterns
        - (1) Powers of 10
        - (2) Expanded form and standard numerals

    - c. Chart: periods and place value through quadrillions
        - (1) Reading the numeral
        - (2) Completing the chart

Methods

Introducing pupils to the use of place value charts is considered. This is connected with work with the abacus and multi-base arithmetic blocks. The reading of numerals to quadrillions is also considered.

Chapter 4: Other Numeration Systems

Content

1. Introduction to base eight
    a. Symbols: counting
    b. Place value
    c. Changing from base ten to base eight
        (1) Finding powers of the base
        (2) Division by the base

2. Introduction to base five
    a. Changing from base five to base ten
    b. Changing from base ten to base five

3. Characteristics of any numeration system
    a. Number of symbols
    b. Writing the base

4. Introduction to base twelve
    a. Changing from base twelve to base ten
    b. Changing from base ten to base twelve

5. Introduction to base two
    a. Changing from base ten to base two
    b. Changing from base two to base ten

6. Addition in other bases
    a. Base five
    b. Base two

7. Multiplication in base five

Methods

Ways of introducing other numeration systems are presented. Use of materials such as the place value chart is considered, and attention is directed to points at which pupils may have difficulty.

Chapter 5: Addition of Whole Numbers

Content

1. Addition as a binary operation

2. Addition as one of four operations
   a. Relation to subtraction
   b. Relation to multiplication

3. Addition as the union of disjoint sets

4. Counting as the basis for addition: use in problem solving

5. Aids for teaching addition
   a. Abacus
   b. Number line
   c. Cuisenaire rods
   d. Place value frame

6. Properties and principles of addition
   a. Closure
   b. Commutativity
   c. Associativity
   d. Identity element

7. Addition basic facts: use of the table

8. Addition algorithms for multi-digit examples
   a. Use of place value
   b. Use of properties
   c. Regrouping
   d. Expanded notation forms

9. Historical forms for addition
   a. Sandboard method
   b. Scratch method
   c. Front-end addition

10. Checking addition
    a. Excess of nines
    b. Excess of elevens

Methods

For this chapter, the methods component is interwoven with the content. Stress is placed on the use of verbal problems and manipulative materials such as the abacus and Cuisenaire rods.

Chapter 6: Subtraction of Whole Numbers

Content

1. Subtraction on the number line

2. Subtraction as the inverse of addition

3. Terminology
    - a. Addend, missing addend, sum
    - b. Minuend, subtrahend, difference

4. Subtraction in terms of sets
    - a. Complements
    - b. Difference between universal set and subset

5. Properties and principles of subtraction
    - a. Closure
    - b. Commutativity
    - c. Associativity
    - d. Compensation and renaming

6. Subtraction basic facts: use of the addition table

7. Subtraction algorithms
    - a. For basic facts
        - (1) Additive method
        - (2) Take-away method
    - b. For multi-digit examples
        - (1) Decomposition
            - (a) Additive
            - (b) Take-away
        - (2) Equal additions
            - (a) Additive
            - (b) Take-away

8. Checking subtraction
    - a. Adding
    - b. Excess of nines
    - c. Excess of elevens
    - d. Complementary method
    - e. Scratch method

9. Subtraction in base eight

Methods

Procedures for introducing subtraction to pupils are developed. Also reintroduction using the abacus as a vehicle is presented, and attention is focused on ways of teaching multi-digit subtraction using expanded notation.

Chapter 7: Multiplication of Whole Numbers

Content

1. Multiplication as repeated addition, using the number line
2. Terminology
   a. Multiplier, multiplicand, product
   b. Factors and product
3. Multiplication in terms of sets
4. Arrays and ordered pairs
5. Properties and principles of multiplication
   a. Identity element
   b. Closure
   c. Commutativity
   d. Associativity
   e. Distributivity
6. Multiplication basic facts: use of the table
7. Multiplication algorithms for multi-digit examples
   a. Regrouping
   b. Use of place value
8. Checking multiplication
   a. Use of properties
   b. Excess of nines
   c. Excess of elevens
9. Historical forms for multiplication
   a. Finger reckoning
   b. Lightning method
   c. Scratch method
   d. Lattice method
   e. Duplation methods
10. Modulus multiplication
    a. Mod 2
    b. Mod 7

Methods

Use of arrays in teaching multiplication is developed. Emphasis is placed on providing pupils with varying methods for finding answers to multiplication questions.

Chapter 8: Division of Whole Numbers

Content

1. Relation of division
    a. To multiplication
    b. To subtraction

2. Terminology
    a. Dividend, divisor, quotient
    b. Types: partition and measurement

3. Properties and principles of division
    a. Closure
        (1) Exact division
        (2) Inexact division
    b. Commutativity
    c. Associativity
    d. Right distributivity
    e. Use of zero except as a divisor
    f. Identity element

4. Division algorithms
    a. For basic facts: use of the multiplication table
    b. For multi-digit examples
        (1) Subtracting groups of the divisor
        (2) Use of place value
        (3) Estimation of quotient
            (a) Approximation
            (b) Compensation
            (c) Determining devisibility

5. Historical forms for division
    a. Galley method
    b. A danda method
    c. Division by factors
    d. Excess of nines

6. Division in base four

Methods

Procedures for the diagnosis of pupil difficulties in division are developed. Provision for individual differences is focused on through the study of procedures for estimating the quotient in division.

Chapter 9: Functions

(to be developed)

Chapter 10: Integers

Content

1. Defining the set of integers
   a. Negative signed numbers
   b. Additive inverse

2. Computation with integers

3. Properties and principles of integers
   a. Closure
   b. Commutativity
   c. Associativity
   d. Distributivity
   e. Identity element

4. Order relations of integers

Methods

Three strategies for introducing a lesson are analyzed and compared. The way in which a teacher can use a textbook with other materials is developed.

Chapter 11: Fractions

Content

1. Defining the set of rational numbers

2. Terminology of fractions

3. Uses of fractions
    a. To express parts of a group and parts of a whole
    b. To name a rational number
    c. To indicate division
    d. To express a ratio

4. Characteristics of fractions
    a. Identity element
    b. Equivalance
    c. Cross-products test
    d. Renaming in simplest form
        (1) Prime numbers
        (2) Composite numbers
        (3) Numbers that are relatively prime

5. Order relations of fractions; mixed forms

6. Properties of fractions
    a. Commutativity
    b. Associativity
    c. Distributivity

7. Computation with fractions
    a. Addition
        (1) Like denominators
        (2) Unlike denominators
    b. Finding the L. C. M.
    c. Finding the G. C. D.
    d. Subtraction
        (1) Like denominators
        (2) Unlike denominators
    e. Multiplication
    f. Division
        (1) Common denominator method
        (2) Multiplicative inverse method (inverse)

Methods

Attention is focused on a lesson plan for summarizing the various uses of fractions. The selection of behavioral objectives and analysis of strengths and weaknesses of the plan are included.

Chapter 12: Decimals

Content

1. Place value for decimals
2. Reading and writing decimals
3. Locating decimals on the number line
4. Renaming
    a. Fractions as decimals
    b. Decimals as fractions
5. Terminating decimals
6. Non-terminating decimals
    a. Repeating
    b. Non-repeating
7. Computation with decimals

Methods

Use of a physical world situation to introduce decimals is emphasized with the presentation of a lesson with an odometer. Pupil participation through the use of multiple solutions is reviewed, and non-verbal problems are suggested.

Chapter 13: Ratio and Per Cent

Content

1. Ratio
   a. Expressing ratios
   b. Solving problems with ratios
   c. Using the cross-product method

2. Per cent
   a. Three types of problems
      (1) What is N% of a number?
      (2) What per cent is one number of another number?
      (3) Find the total (100%) when a per cent is known
   b. Five approaches to solving each type of problem
      (1) Decimal
      (2) Ratio
      (3) Unitary-analysis
      (4) Formula
      (5) Equation

Methods

This section is essentially a review and test of material presented in Chapter 10 of the course textbook by Riedesel. When and how ratio and per cent should be developed are emphasized.

APPENDIX B

Student Opinion Toward Computer-Assisted Instruction

STUDENT OPINION TOWARD COMPUTER-ASSISTED INSTRUCTION

1. The method by which I was told whether I had given a right or wrong answer became monotonous.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

2. Nobody really cared whether I learned the course material or not.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

3. I felt challenged to do my best work.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

4. I felt isolated and alone.

All the time	Most of the time	Some of the time	Very Seldom	Never

5. I felt as if someone were engaged in conversation with me.

All the time	Most of the time	Some of the time	Very Seldom	Never

6. As a result of having studied by this method, I am interested in learning more about the subject matter.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

7. I was more involved in operating the terminal than in understanding the course material.

All the time	Most of the time	Some of the time	Very Seldom	Never

8. The learning was too mechanical.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

9. I felt as if I had a private tutor.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

10. The equipment made it difficult to concentrate on the course material.

All the time	Most of the time	Some of the time	Very Seldom	Never

11. The situation made me quite tense.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

12. Computer-assisted instruction, as used in this course, is an inefficient use of the student's time.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

13. My feeling toward the course material after I had completed the course was favorable.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

14. I felt frustrated by the situation.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

15. I found the computer-assisted instruction approach in this course to be inflexible.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

16. Material which is otherwise interesting can be boring when presented by CAI.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

17. I was satisfied with what I learned while taking the course.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

18. In view of the amount I learned, this method seems superior to classroom instruction for many courses.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

19. I would prefer computer-assisted instruction to traditional instruction.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

20. Computer-assisted instruction is just another step toward de-personalized instruction.

Strongly Disagree | Disagree | Uncertain | Agree | Strongly Agree

21. I was concerned that I might not be understanding the material.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

22. The responses to my answers seemed appropriate.

All the time	Most of the time	Some of the time	Very Seldom	Never

23. I felt uncertain as to my performance in the programmed course relative to the performance of others.

All the time	Most of the time	Some of the time	Very Seldom	Never

24. I was not concerned when I missed a question because nobody was watching me.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

25. I found myself just trying to get through the material rather than trying to learn.

All the time	Most of the time	Some of the time	Very Seldom	Never

26. I knew whether my answer was right or wrong before I was told.

All the time	Most of the time	Some of the time	Very Seldom	Never

27. In a situation where I am trying to learn something, it is important to me to know where I stand relative to others.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

28. I guessed at the answers to some questions.

All the time	Most of the time	Some of the time	Very Seldom	Never

29. I was aware of efforts to suit the material specifically to me.

All the time	Most of the time	Some of the time	Very Seldom	Never

30. I was encouraged by the responses given to my answers of questions.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

31. In view of the time allowed for learning, I felt too much material was presented.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

32. I entered wrong answers in order to get more information from the machine.

All the time	Most of the time	Some of the time	Very Seldom	Never

33. I felt I could work at my own pace.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

34. Questions were asked which I felt were not related to the material presented.

All the time	Most of the time	Some of the time	Very Seldom	Never

35. I was aware of the flickering screen while I was taking the course.

All the time	Most of the time	Some of the time	Very Seldom	Never

36. Material which is otherwise boring can be interesting when presented by CAI.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

37. I could have learned more if I hadn't felt pushed.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

38. I was given answers but still did not understand the questions.

All the time	Most of the time	Some of the time	Very Seldom	Never

39. The course material was presented too slowly.

All the time	Most of the time	Some of the time	Very Seldom	Never

40. The responses to my answers seemed to take into account the difficulty of the question.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

41. While on computer-assisted instruction, I encountered mechanical malfunctions.

All the time	Most of the time	Some of the time	Very Seldom	Never

42. Computer-assisted instruction did not make it possible for me to learn quickly.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree